MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

EEL4106 – HIGH VOLTAGE ENGINEERING

(LE)

13 OCTOBER 2018
2.30 p.m - 4.30 p.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 4 pages including the cover page with 4 Questions only.

2. Answer **ALL** questions. The distribution of the Marks for each question is given.

3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) Design a half-wave rectifier which can generate $100V_{DC}$ with ripple voltage not exceeding 1% of the peak output DC voltage. The design is expected to be used in Malaysia and only resistor and capacitor with rating as shown in Table Q1 can be used. Assume that the voltage drop across the diode is negligible and the load is purely resistive (select from Table Q1). Draw the circuit of your design and explain the function of each component. Clearly illustrate all the steps taken in your design. [19 Marks]

Table Q1

R (Ω)	C (nF)
10k	200
100k	300
1M	400

(b) Transient overvoltage originates from lightning and switching impulses.

(i) Briefly explain the effect of transient overvoltage on power systems. [2 Marks]

(ii) Furnish **TWO** differences between lightning and switching impulse. [4 Marks]

Question 2

(a) Sphere gaps is a standard method used to measure peak value of DC, AC and impulse voltages. It is basically a system with two identical metallic spheres separated by certain distance thus forming a sphere gap. State **FIVE** specifications of a sphere gap. [5 Marks]

(b) A uniform field spark gap is important to ensure that the breakdown voltage is always within a known tolerance under constant atmospheric conditions. Uniform field electrode gaps as shown in Figure Q2b has the advantage of extending the range of sphere gaps with uniform electric field.

(i) Estimate the value of s if the breakdown voltage across the gap was measured to be 30kV at 20^0 C and 760 mm Hg. [5 Marks]

(ii) If the experimental setup is being exposed to ultra-violet rays, explain what would happen to the breakdown voltage. [3 Marks]

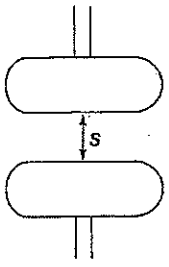

Figure Q2b

Continued...

(c) The High voltage Schering bridge as shown in Figure Q2c is used to measure the insulating properties of high voltage cables and equipment. An unknown specimen, X, is tested at 50 Hz using a Schering Bridge. The bridge has a standard compressed air capacitor of 100 pF (C_s) and a non-inductive variable resistor, R_3. A non-inductive resistance R_4 = 250 Ω is in parallel with a variable capacitance C_4. If balance is obtained with C_4 = 300 nF and R_3 = 400 Ω, determine the loss factor and the capacitance and resistance of the sheet using series equivalent model.

[6 Marks]

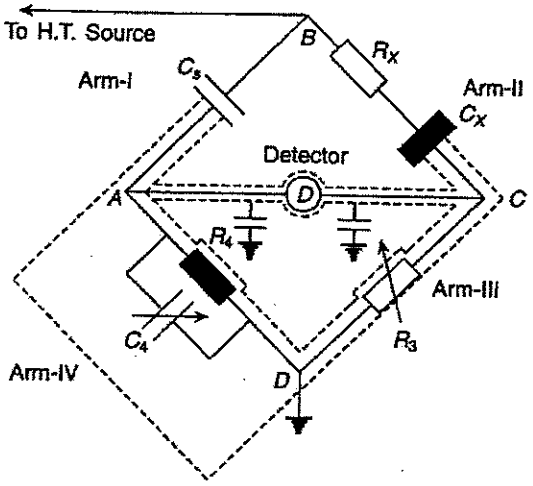

Figure Q2c

(d) State and briefly explain the **THREE** types of standard tests in high voltage testing.

[6 Marks]

Question 3

(a) State and briefly explain **THREE** important properties of a dielectric for an electrical power engineer involved in insulation coordination. [6 Marks]

(b) Gas breakdown occurs due to the build-up of high currents caused by the ionization process. In an experiment using certain gas, it was found that a steady state current of 500 μA flowed through the plane electrode separated by a distance of 0.6 cm when a voltage of 10 kV is applied.

(i) Determine the Townsend's first iteration coefficient if a current of 50 μA flow when the distance of separation is reduced to 0.1 cm and the field is kept constant at the previous value. [5 Marks]

(ii) If the breakdown in gas occurred when the gap distance was increased to 0.9 cm, calculate the value of Townsend's secondary ionization coefficient. [5 Marks]

(c) State and explain the **THREE** theories of commercial liquid breakdown due to presence of impurities. [9 Marks]

Continued...

Question 4

(a) Surge diverter is an essential protective device in insulation coordination. Based on Figure Q4a, explain the working principle of a surge diverter. [3 Marks]

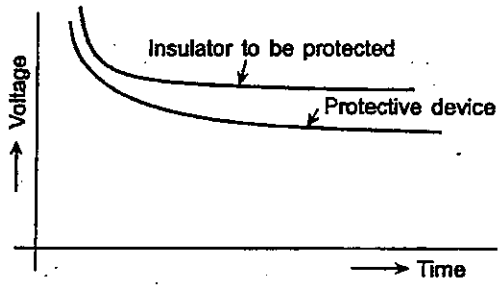

Figure Q4a

(b) Rank the peak kV rating of the following equipment in a substation to ensure that there is a proper insulation coordination:
Bus bar; Lightning arrester; Line; Transformer. [4 Marks]

(c) Recommend and explain TWO ways to minimize the hazard which exists in Figure Q4c.

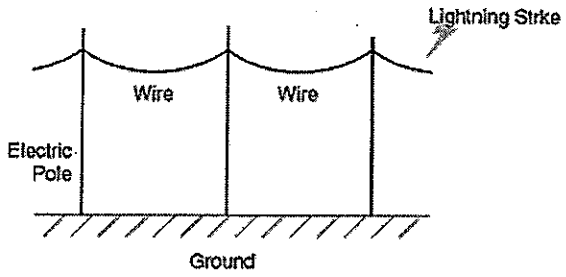

Figure Q4c

[4 Marks]

(d) A rectangular voltage wave of 1500 kV is traveling along a line of surge impedance 200 Ω towards a lightning arrester. A 30% basic insulation level is chosen and the lightning arrester is assumed to be fairly constant at all current values discharged by the arrester. Calculate:

(i) the arrester protective level [2 Marks]

(ii) the current flowing through the line before the surge voltage reaches the arrester terminal [2 Marks]

(iii) the current through the arrester [3 Marks]

(iv) the reflection and refraction coefficients of voltage at the arrester terminals [5 Marks]

(v) the arrester resistance [2 Marks]

End of the Paper.